

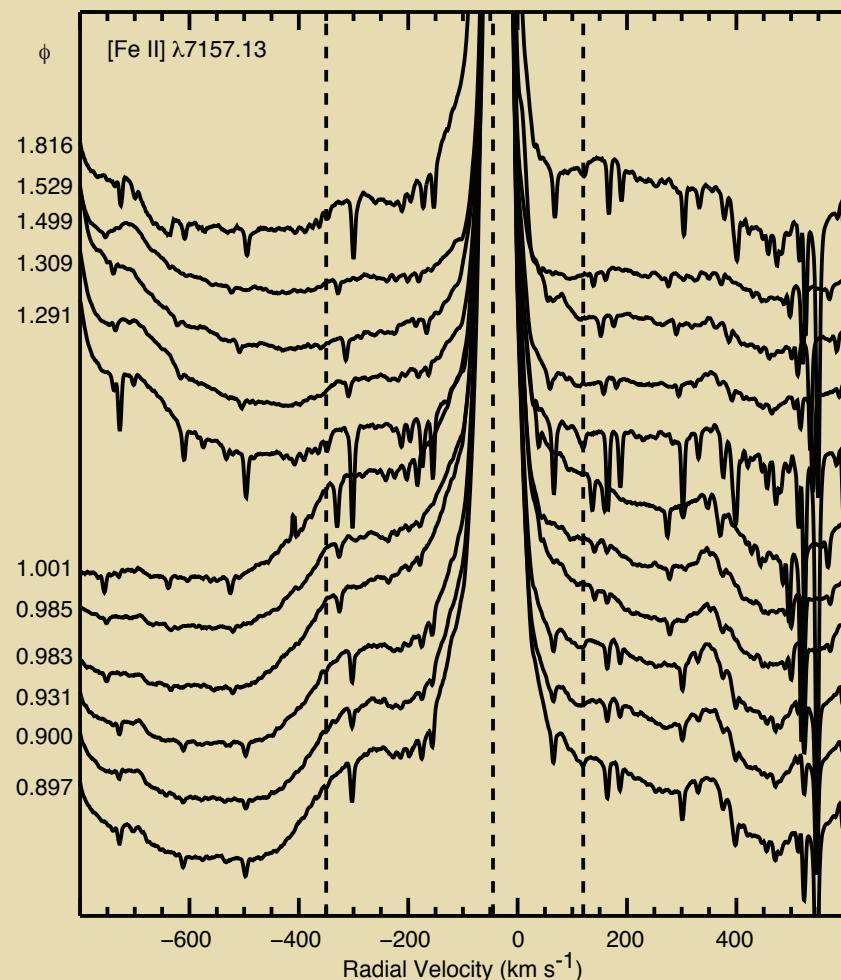
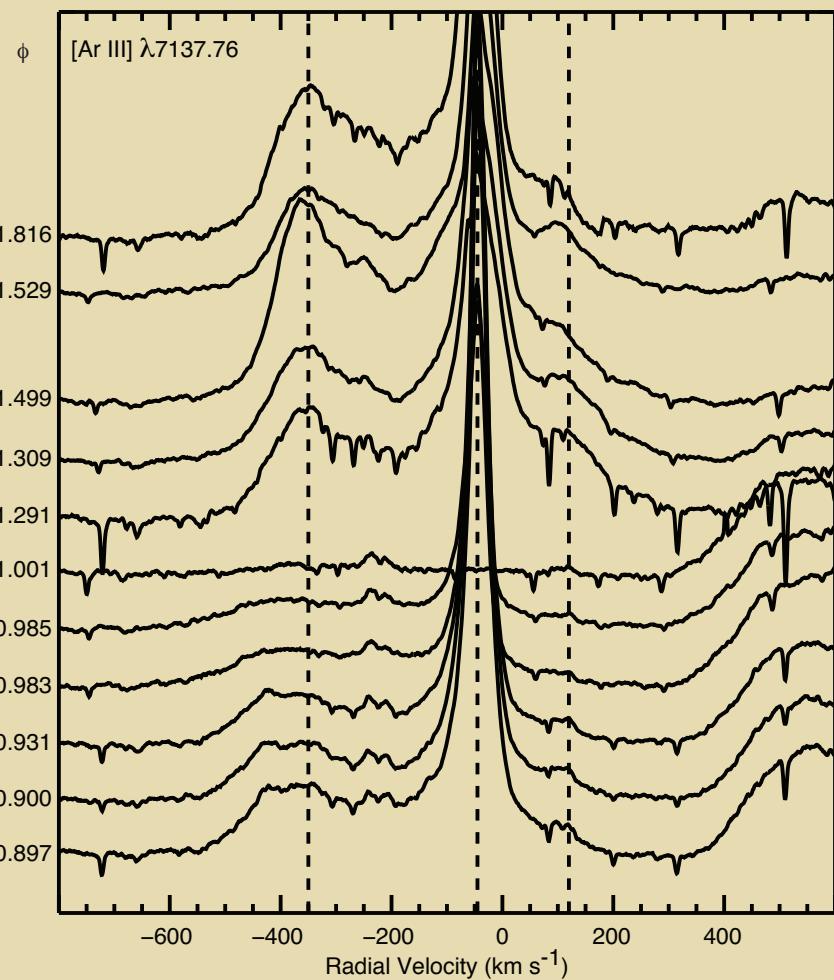
The Extended Winds of Eta Carinae

A composite image of the star Eta Carinae and its surrounding nebula. The central star is a massive, luminous blue-white object, appearing as two large, textured lobes. It is surrounded by a complex, multi-colored nebula in shades of red, orange, yellow, and purple, representing different ionized gases (such as oxygen, hydrogen, and nitrogen). The nebula extends far beyond the immediate vicinity of the star, showing intricate filaments and wisps of light against a dark background of space.

Ted Gull,
NASA/GSFC

- * Emission structure due to the winds of Eta Carinae extend on the scale of $0.7'' \sim 1600$ AU
- * We can trace the outer wind structure and infer the wind-wind interaction geometry
- * Coupled with X-ray data and scattered wind profiles off of selected areas of the Homunculus, we gain considerable knowledge of the binary system, including orbit geometry.

Line profile variations with phase



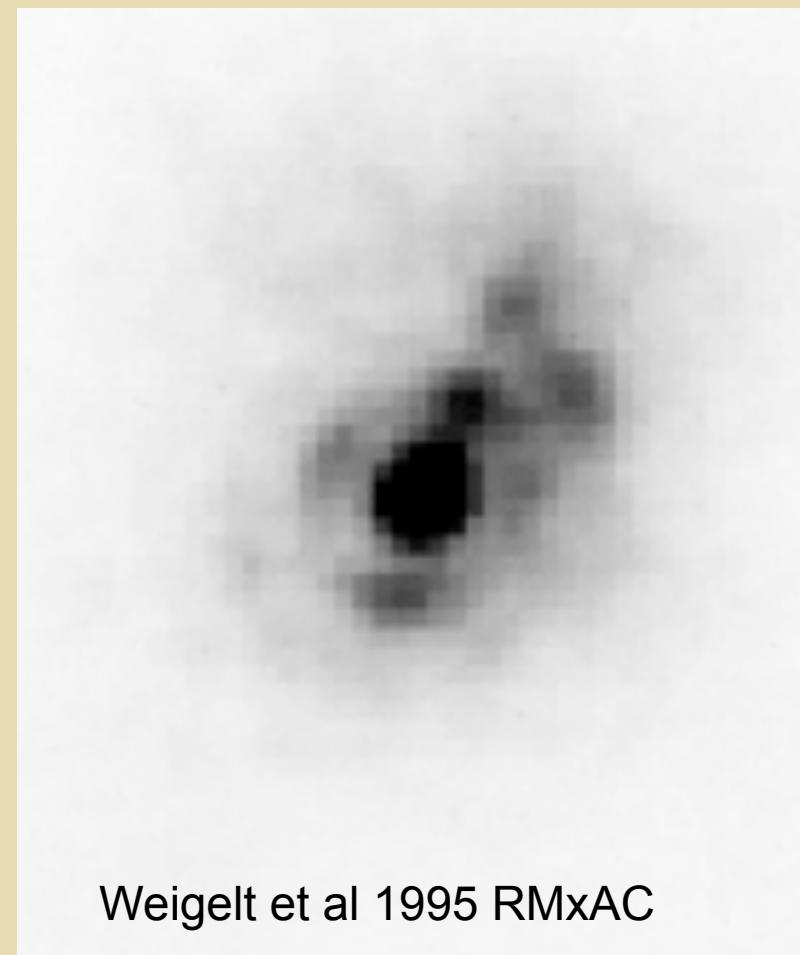
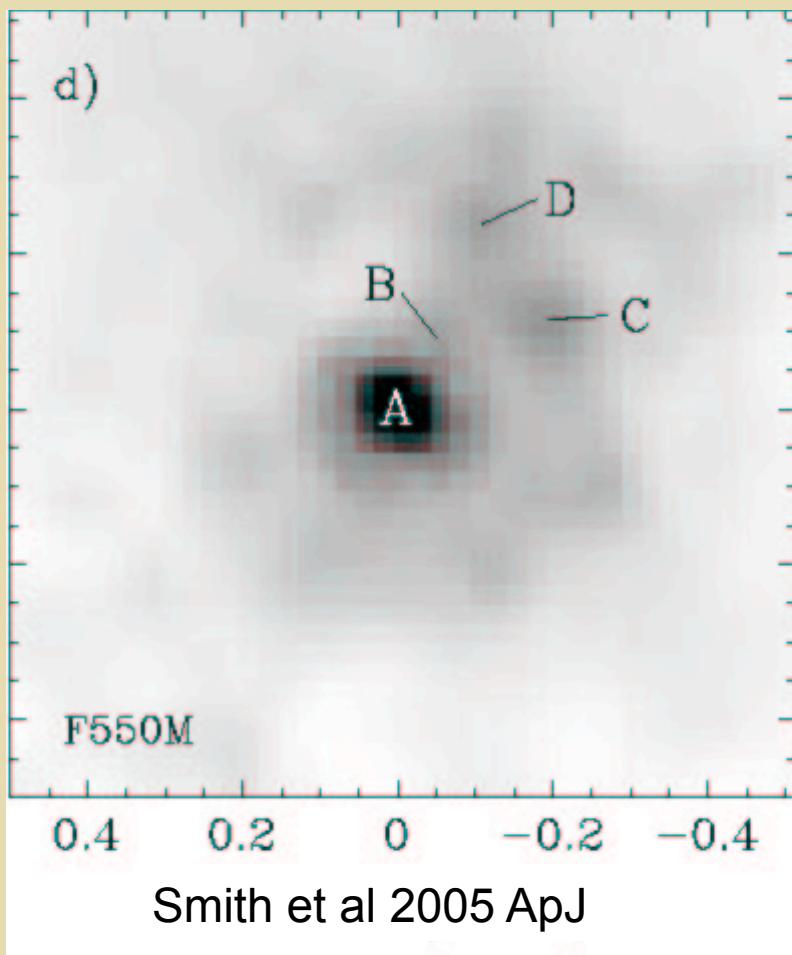
As recorded by VLT/UVES R=80,000, 1-2"

η Car and HST/STIS

STIS repaired during SM4!!!

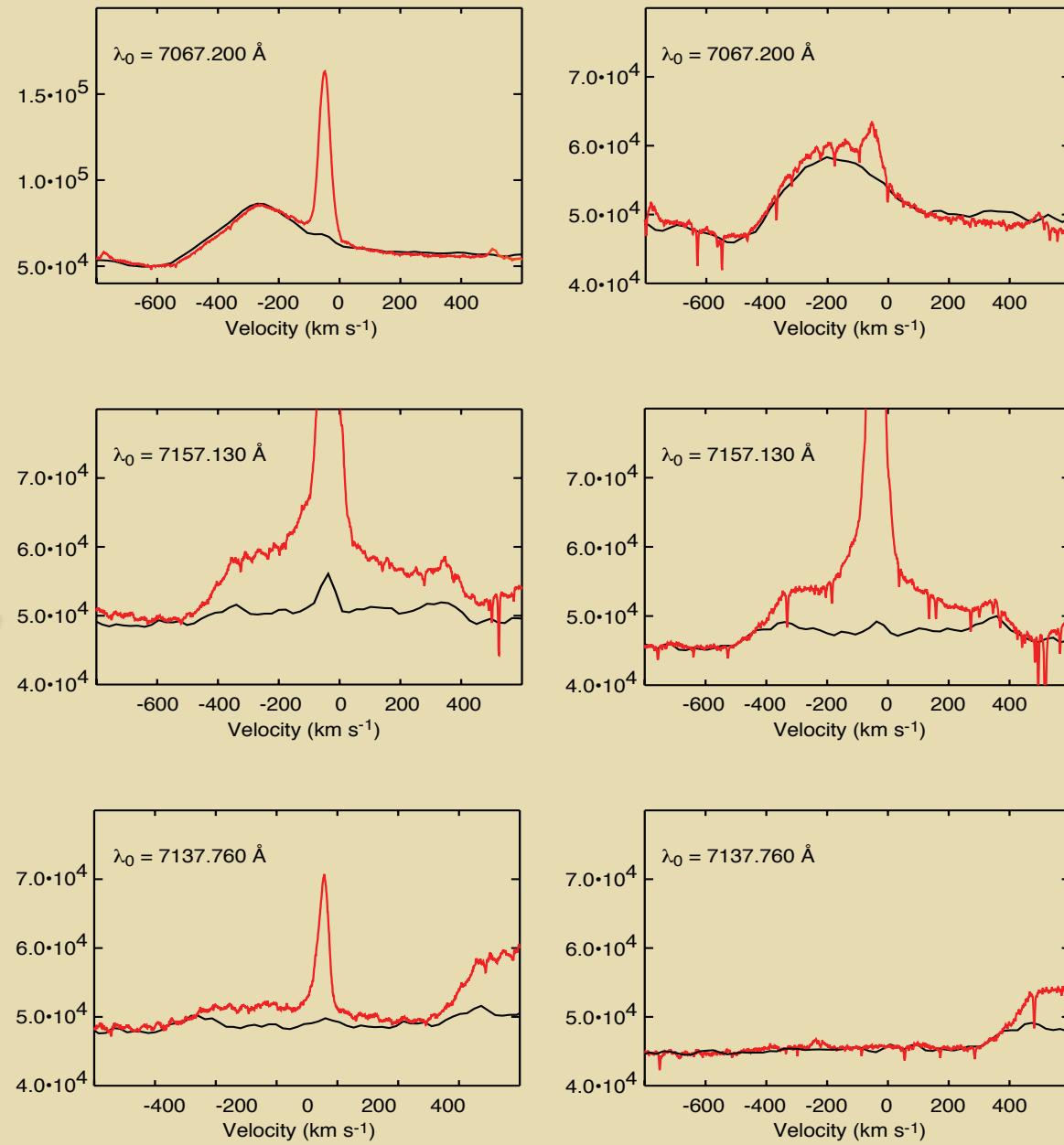
HST/Treasury programs 1998-2004.3 provided a wealth of info.

- Advantage of HST/STIS: R=8000, 0.1" angular resolution separates the spectrum of Eta Carinae from the nebular spectra.
But.....
..... It samples only part of the wind structure!

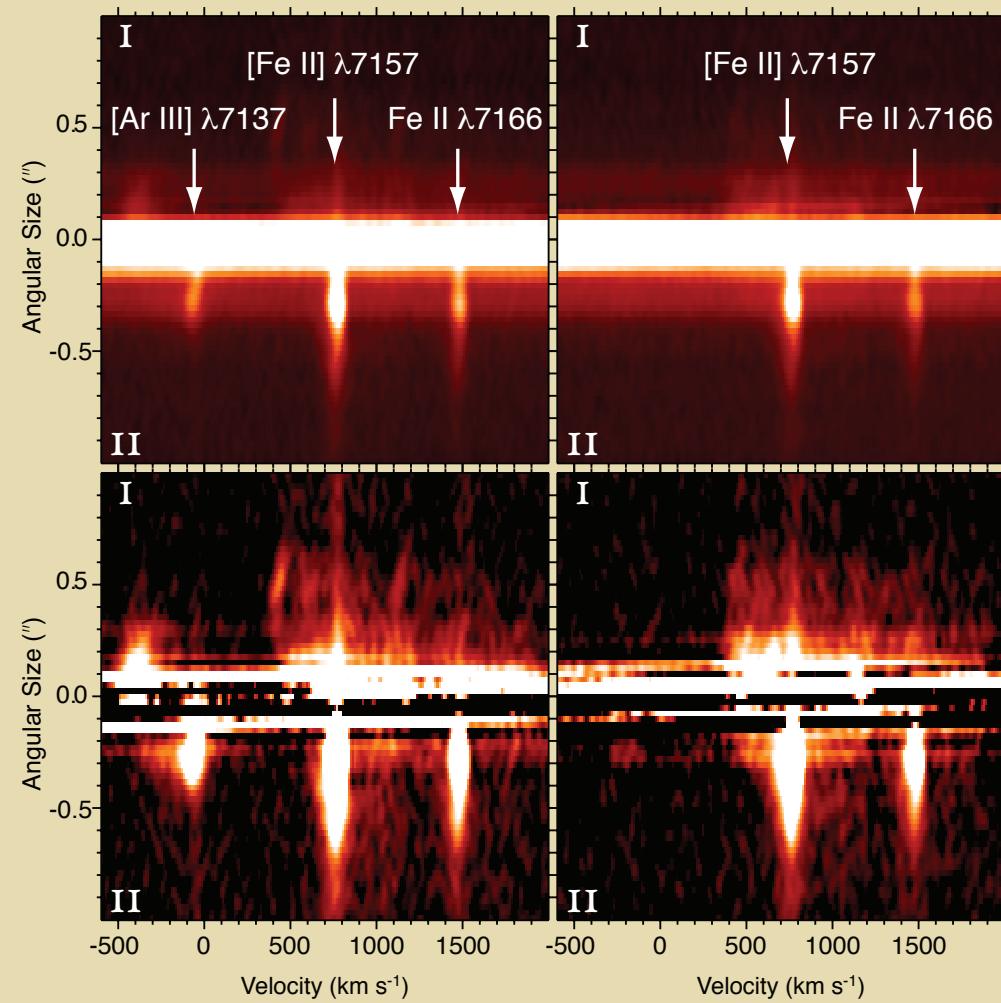
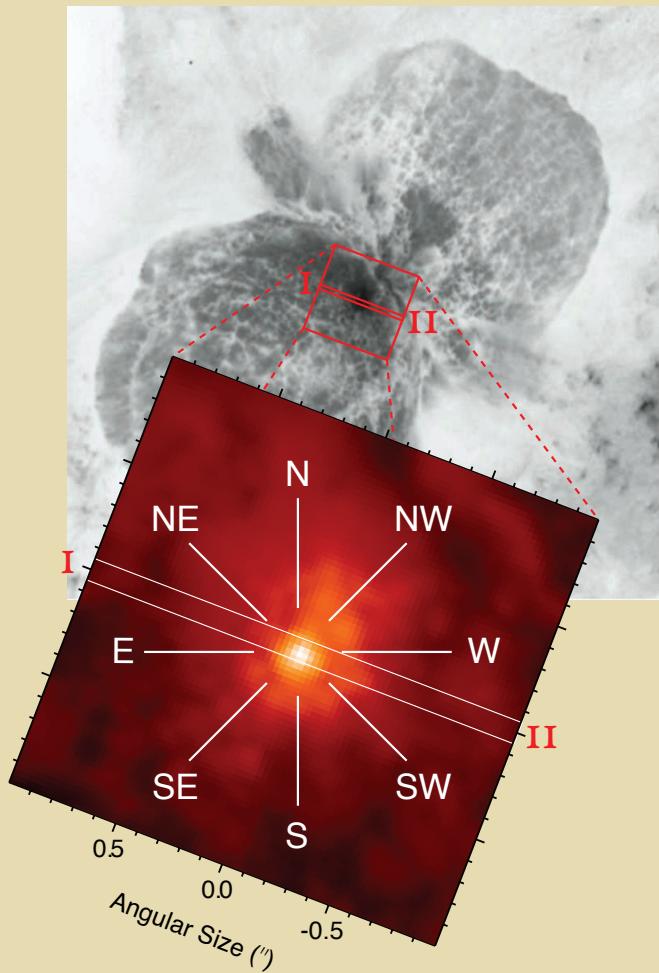


Comparison of VLT/UVES (1" seeing) to STIS (0.1" resolution) line profiles

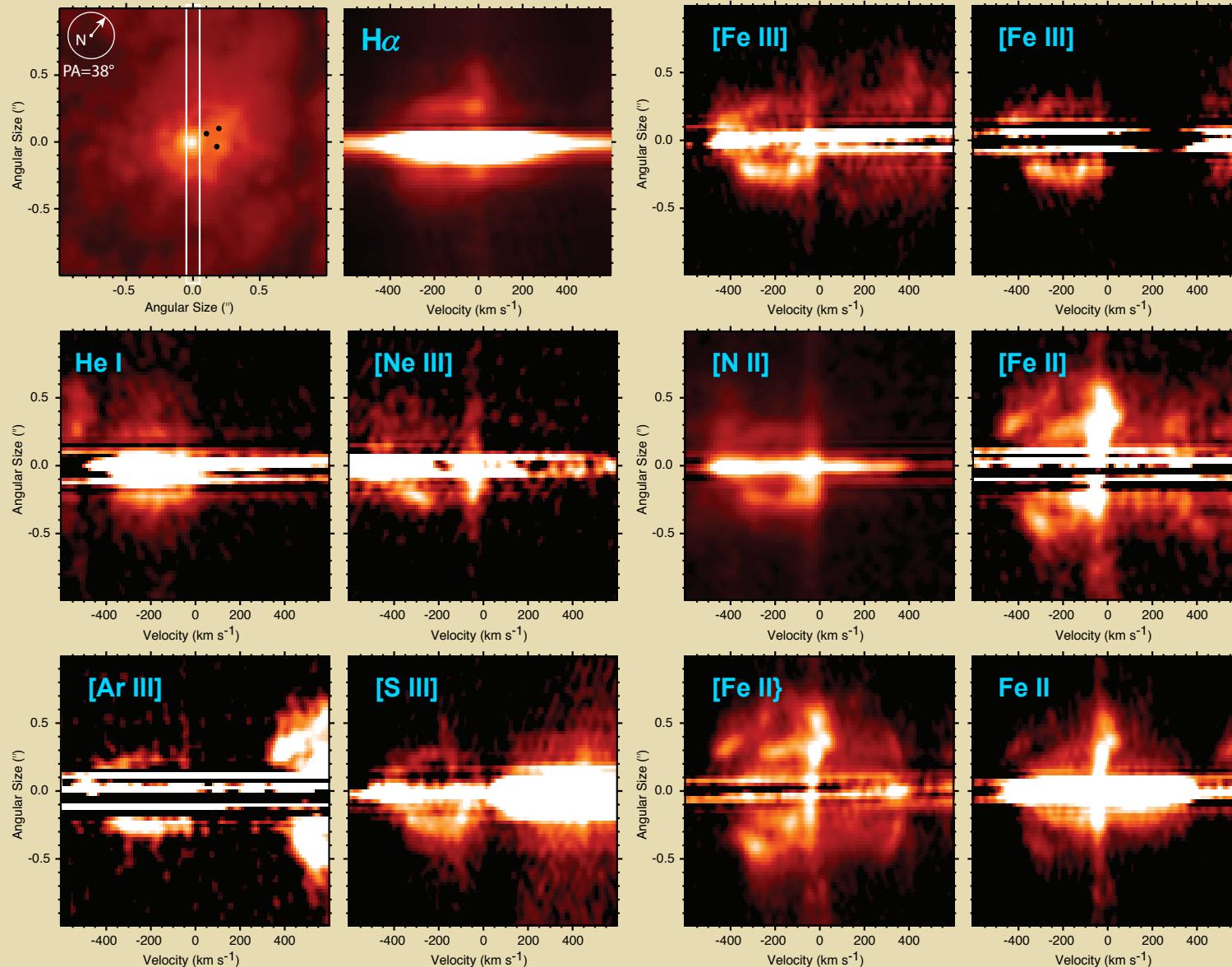
STIS sees only
a slice of the
extended
wind
structures



HST/STIS spatially resolved the winds!



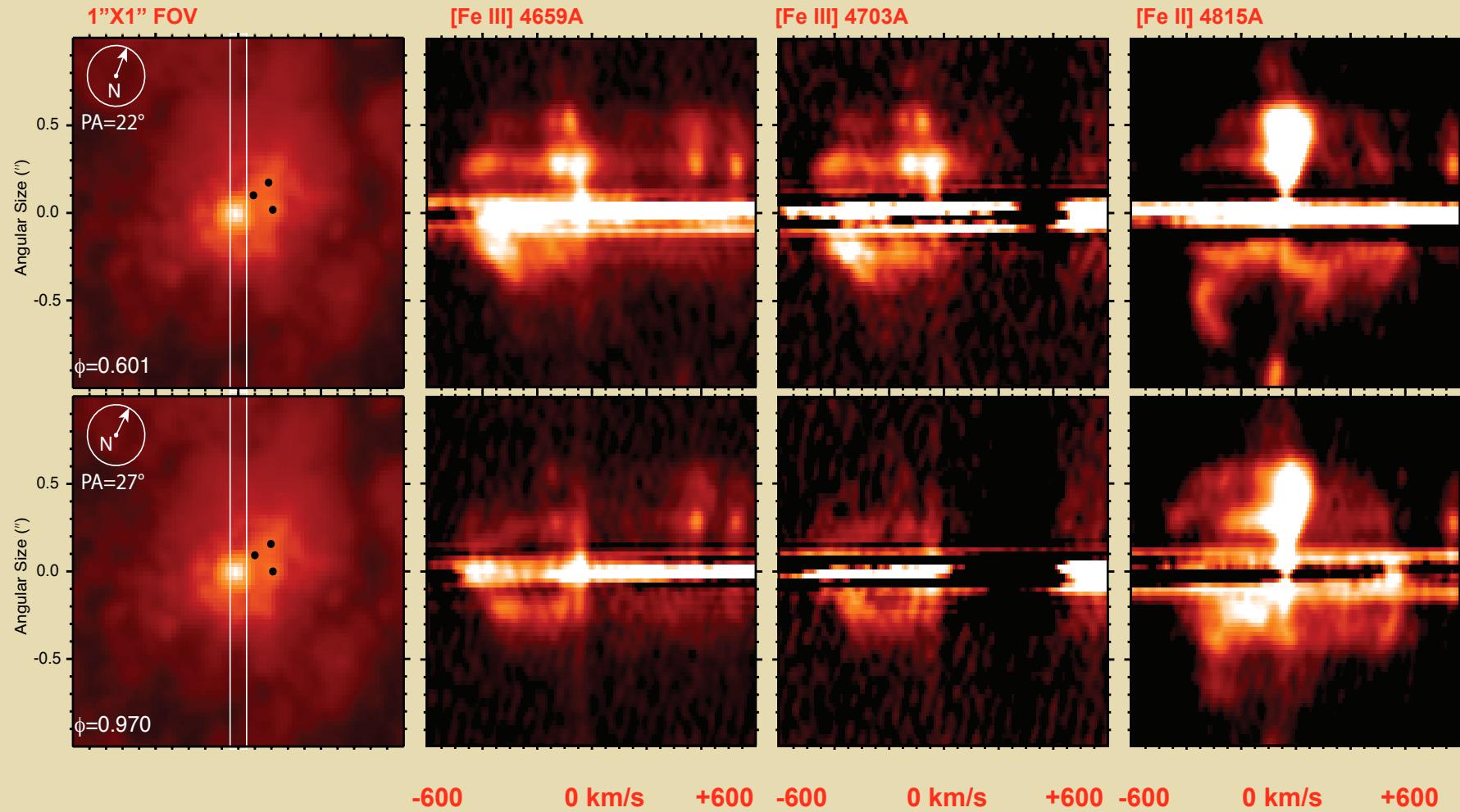
Variations with ionization potential



Forbidden emission lines from wind interface

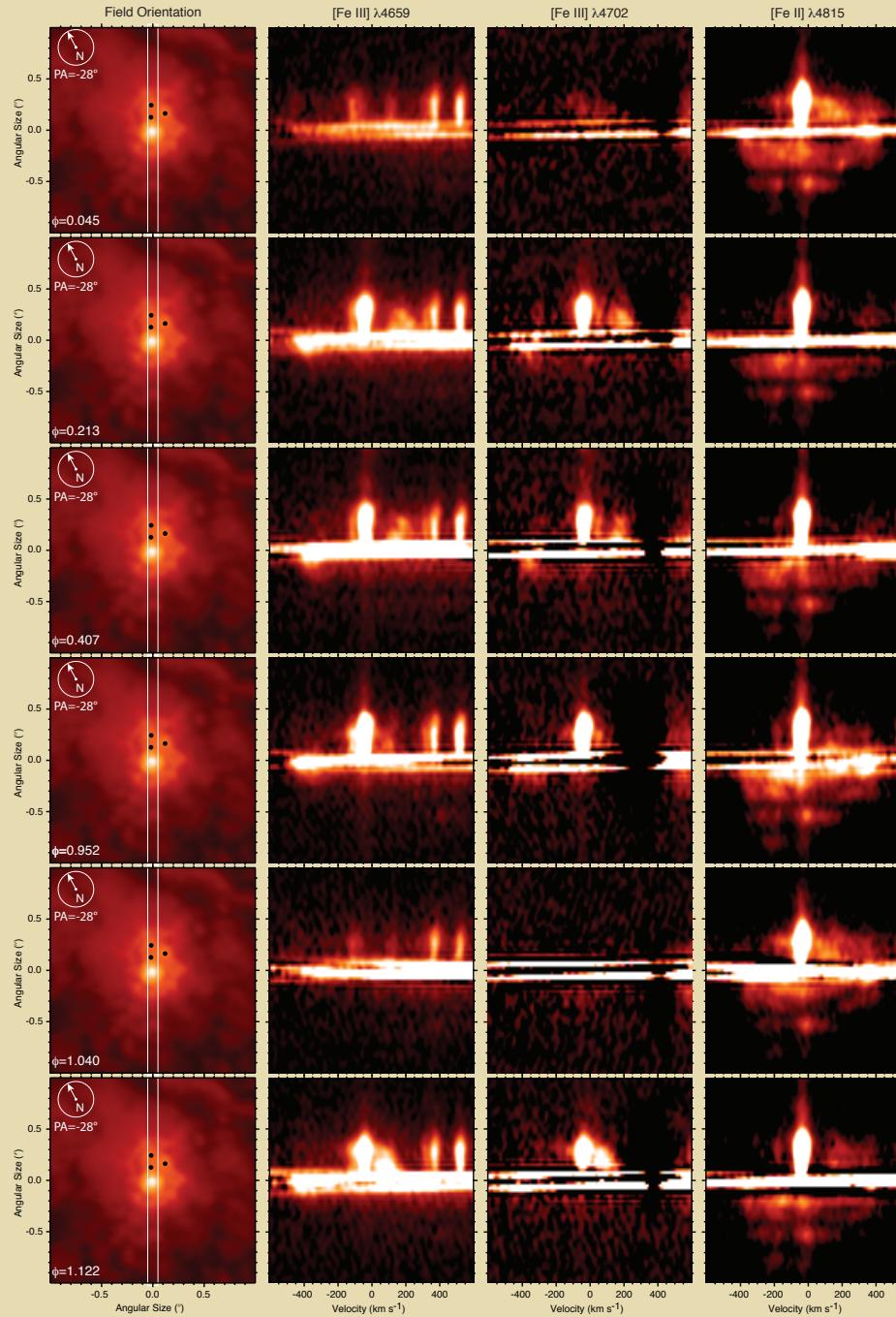
[Fe III] from wind-wind interface:

[Fe II] from primary wind



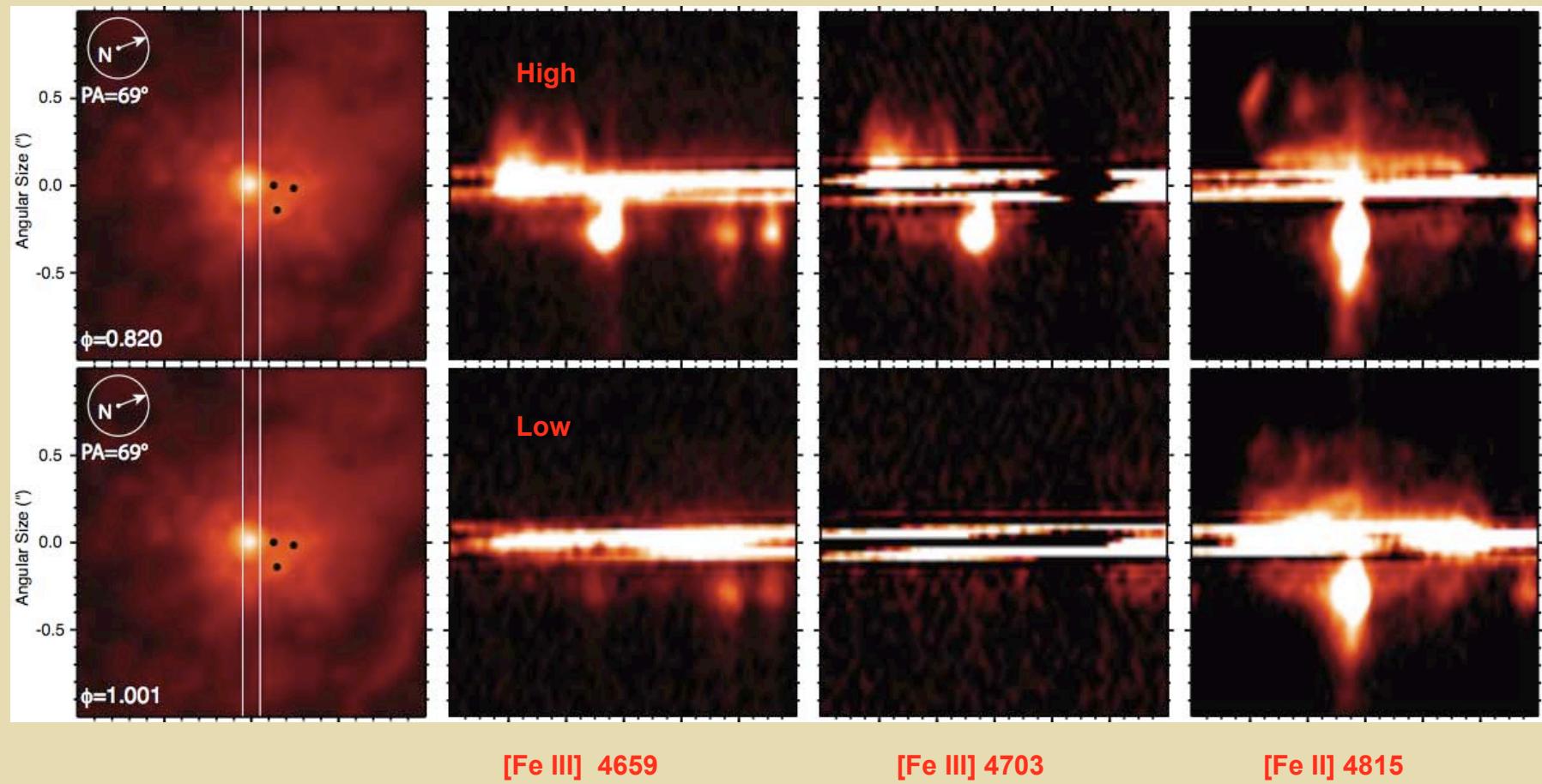
Variations with
orbital phase at
constant position
angle
 $= -28^\circ$

[Fe III]
disappears
during low state
[Fe II]
strengthens
during low state



Changes from high to low state

[Fe III] disappears, [Fe II] backfills...
due to drop in far-UV from hot secondary star

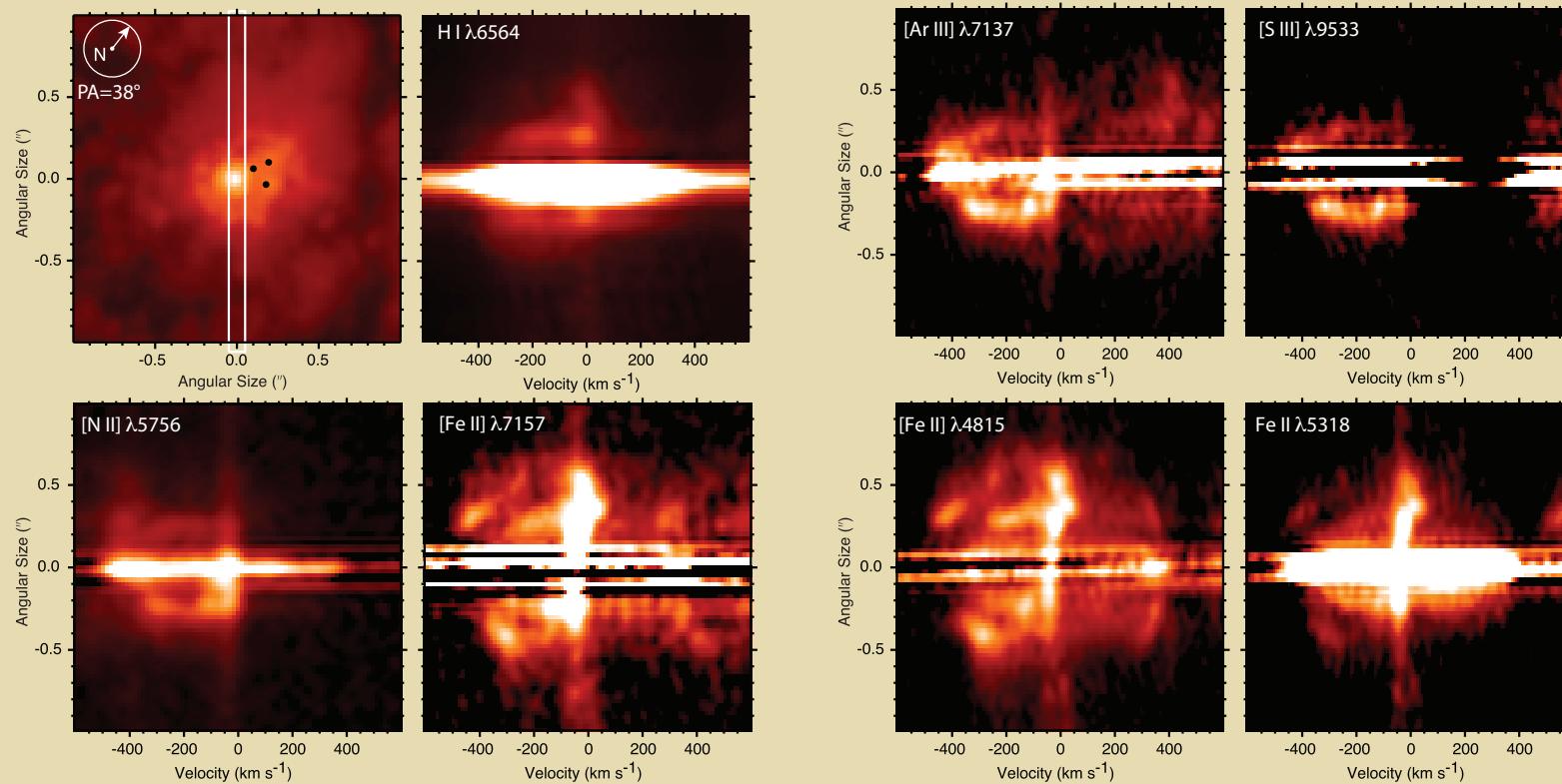


Wind structure changes with ionization:

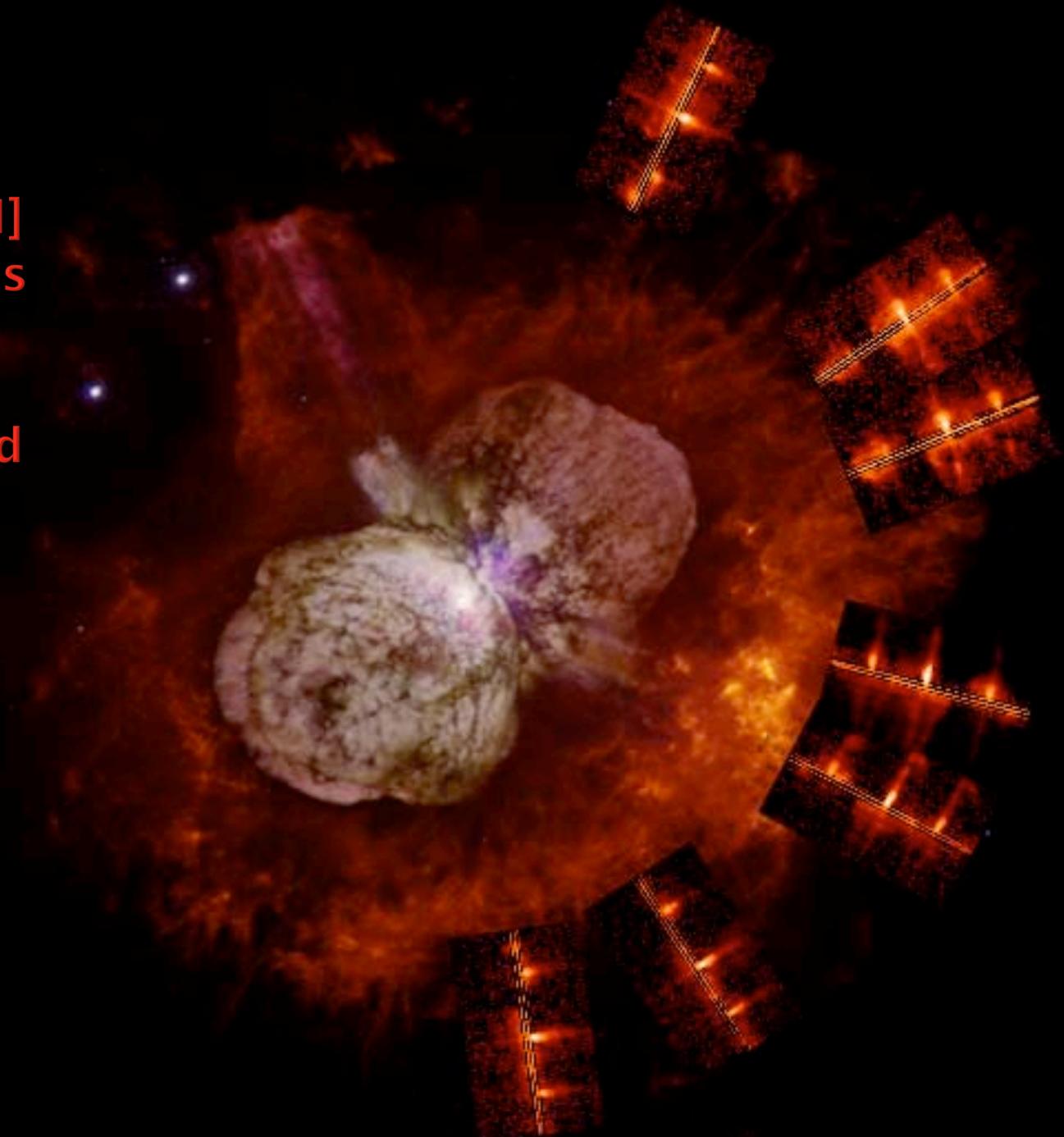
H I , Fe II <0.1"

[Fe II] 1.4" +/- 500 km/s range

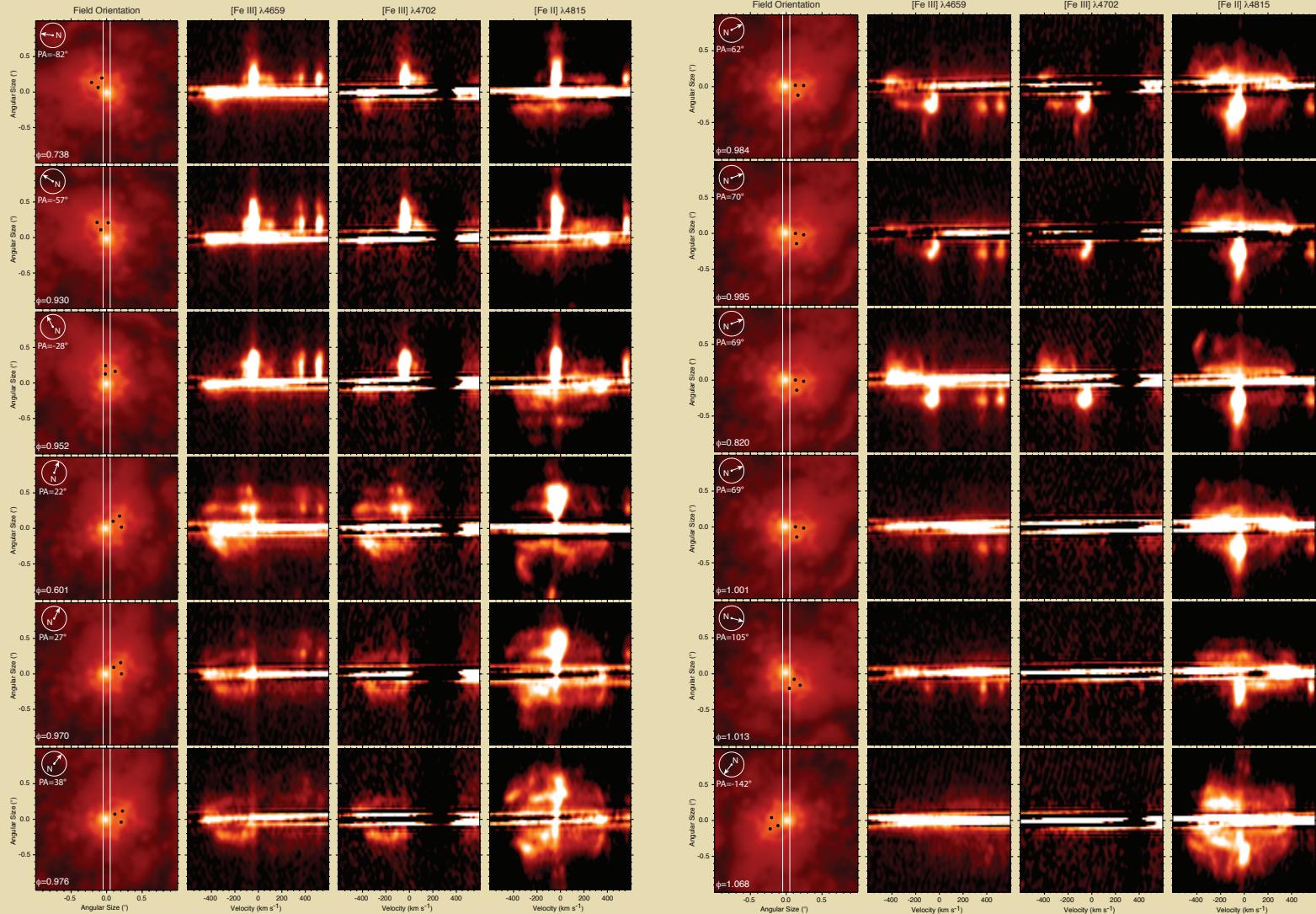
[Fe III], [S III], [Ar III] 0.7", +200 to -500 km/s



**Structure of
central region:
[Ar III] and [Fe II]
spectral slices as
function of
position angle
across the broad
maximum**



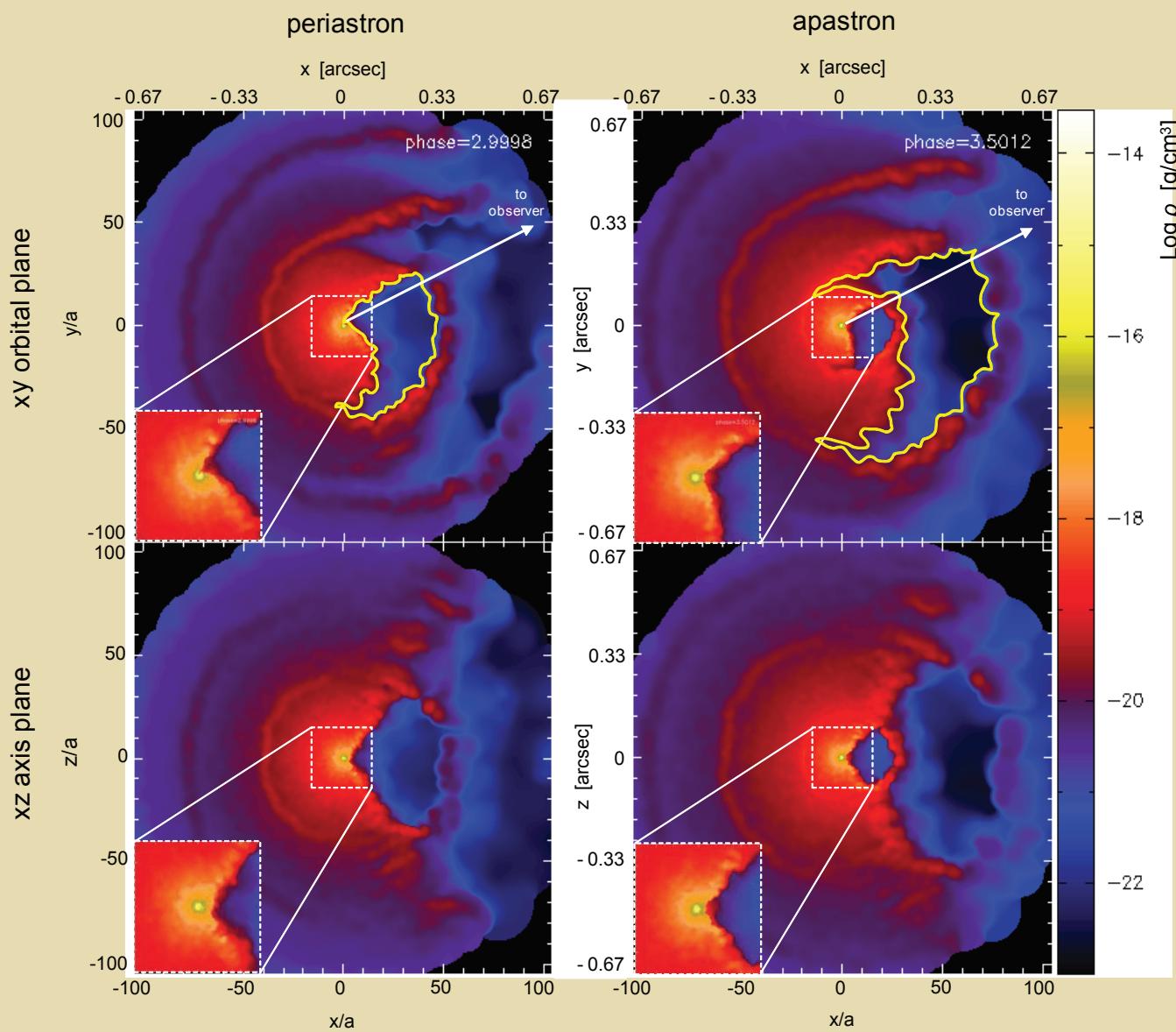
Variations with phase & position angle



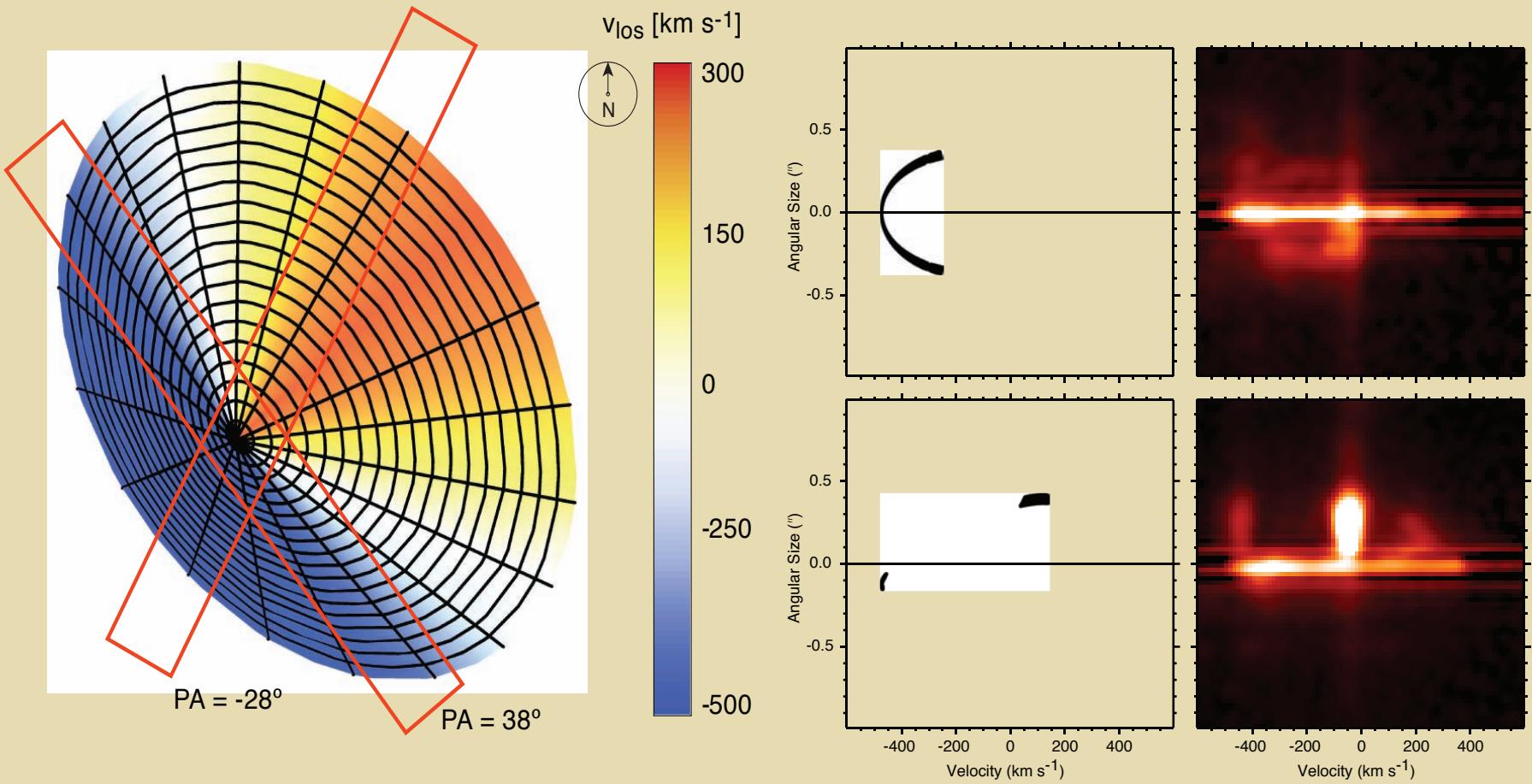
The doubly-ionized, forbidden emission changes with phase and position angle due to shifting of the wind-wind structure which bounds the FUV from the hot secondary.

**SPH
simulation
of
interacting
winds**

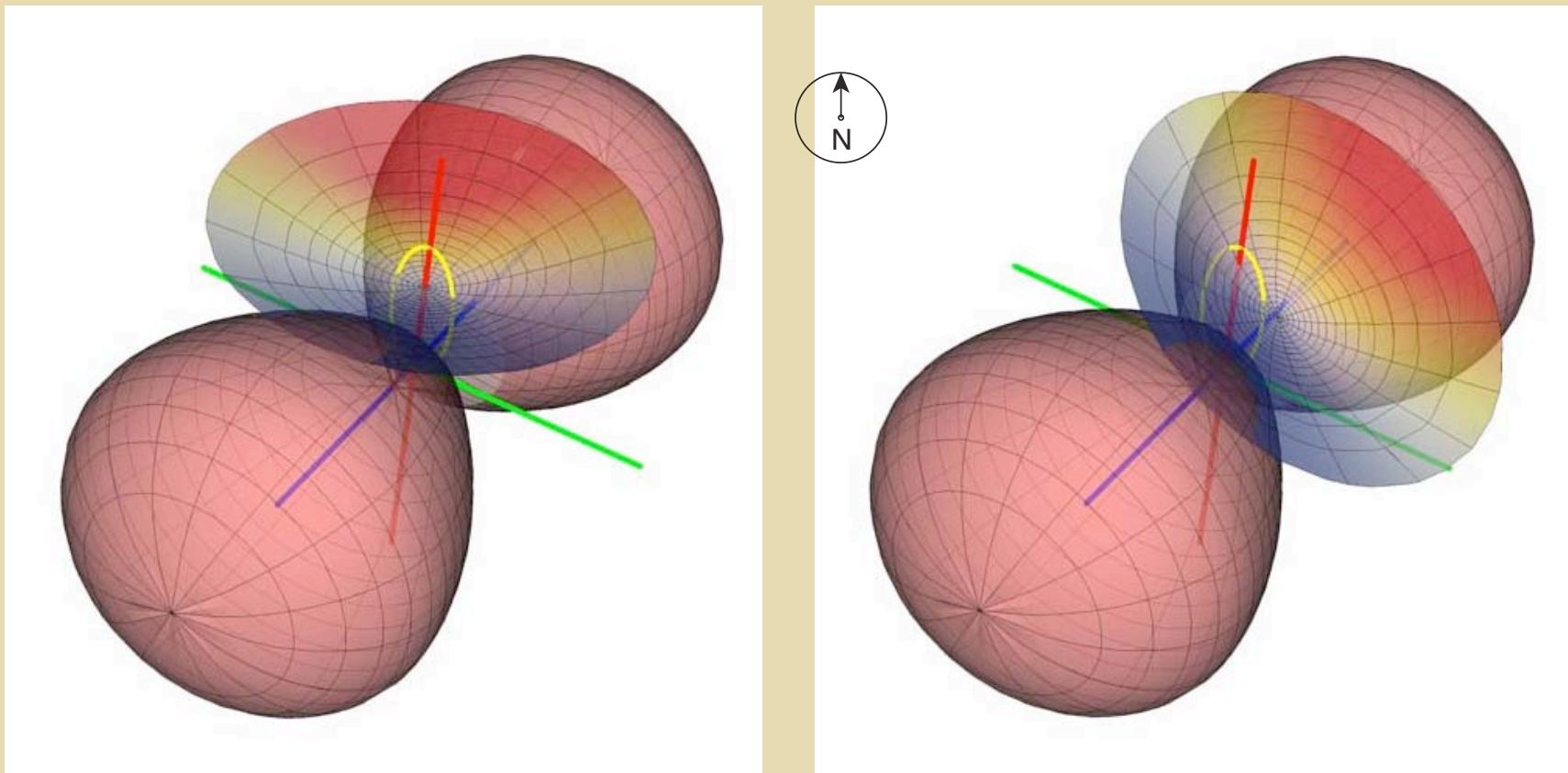
[Fe III], [Ar III], [Ne III], [S III]
originate from the wind-wind boundaries where illuminated by the FUV of Eta Car B



Simple paraboloidal fit to observed [N II] profiles.... Latitude wind dependence must be added



The cavity carved out by the secondary wind shifts in a prograde direction from the binary orbital axis due to the huge buildup of primary wind during periastron passage.



Eta Carina has brightened at visible wavelengths. Is all getting brighter?

No! The obscuration in the primary wind is dropping.

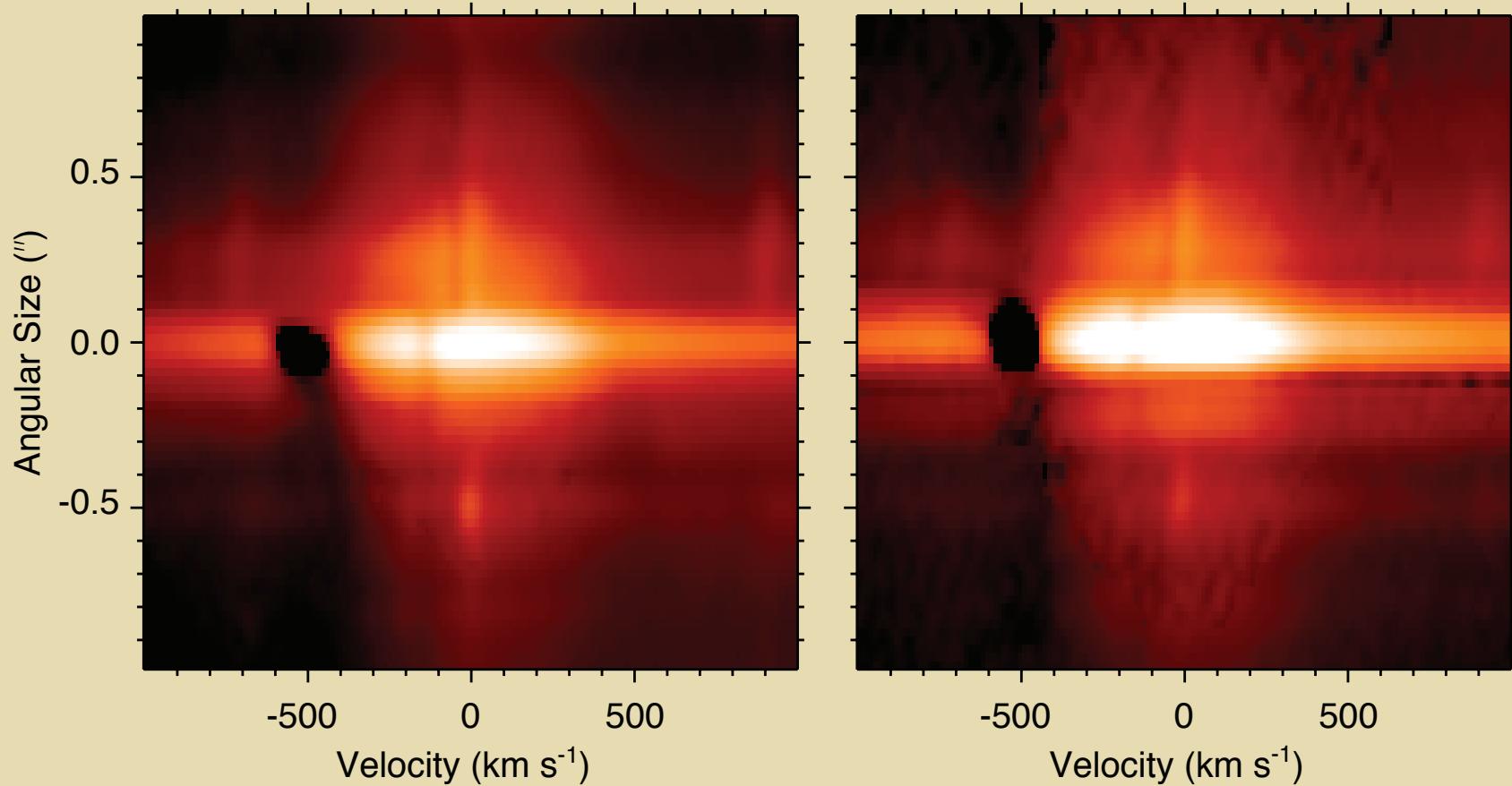
- 1. The emission line spectrum of the Weigelt condensations B and D has the same intensity at the same orbital phase.**
- 2. The scattered starlight off of Weigelt B and D is narrower and has not changed in brightness while the broad primary wind profiles have brightened along with continuum.**

**H α Spectroimages extending
across Eta Carinae and Weigelt B & D**

Left: high state

Right: low state

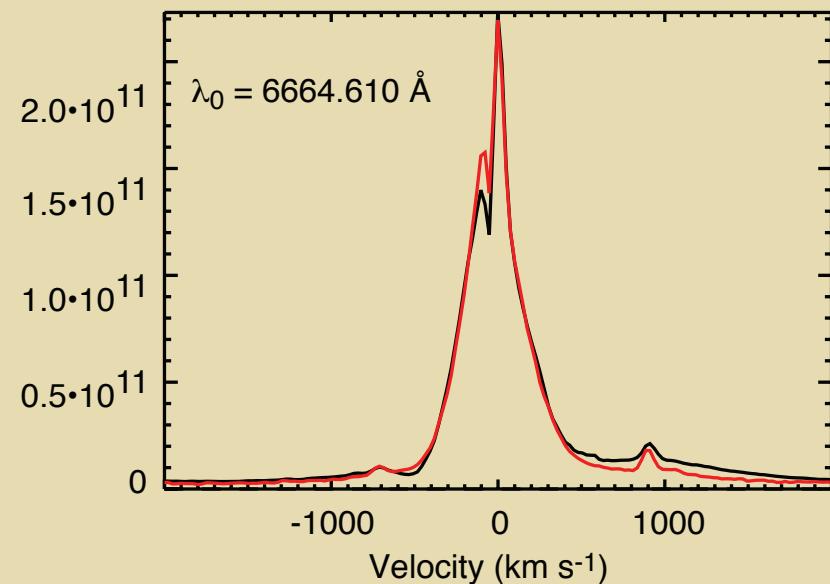
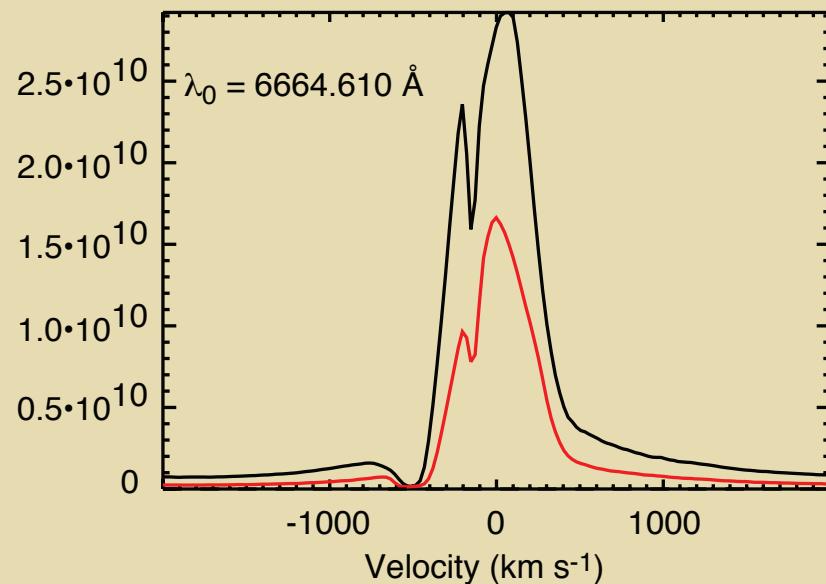
**The strong P Cygni absorption is nearly absent in the light
scattered by Weigelt B & D**



H α Profiles

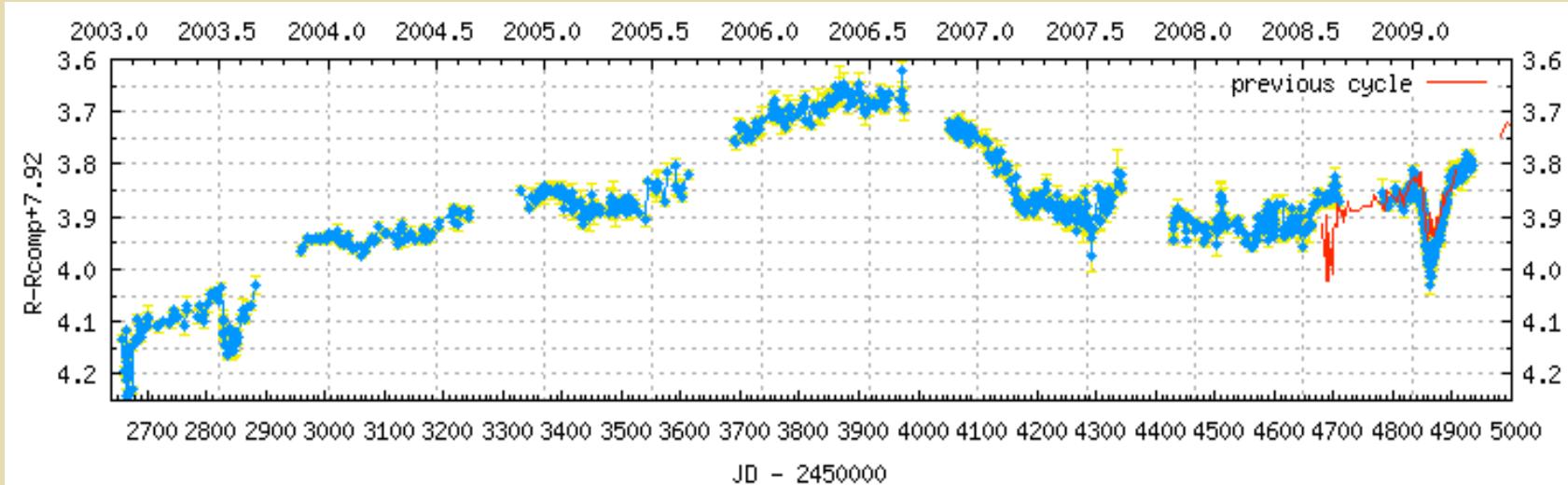
Left: Eta Carinae Right: Weigelt D

Weigelt D reflects profile of secondary star?



Ongoing ground-based photometry:

LaPlata Observatory, Argentina
UBVRI beginning in 2003.0 to present.
--photometry sees ingress and egress!



See posters by Fernandez-Lajus et al and by Madura et al.

Extended forbidden emission describes the structure of the primary wind and the wind interaction.

SPH and a simple geometric model of a paraboloid qualitatively describes the forbidden emission.

Radiative transfer with 3-D hydro code is needed to fully describe the structures and how they vary with phase.

The structures are consistent with periastron on the far side with orbital plane aligned with the Homunculus skirt.